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AUTHOR Boe, Robyn; And Others
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ABSTRACT

Many students, even after formal science instruction, have not developed a scientifically acceptable concept of "living," "animal," or "plant." Therefore, as part of the action-research phase of the Learning in Science Project, a working group was formed to explore (with teachers) some possible strategies aimed at modifying students' current concepts toward scientifically acceptable ones. The goal was not to create specific strategies to teach a scientifically acceptable concept, but to set up a learning environment which forces students to challenge their own concepts, and eventually finding them to be inadequate, to see the need to modify them. A survey of student concepts was conducted before and after teachers used materials developed (including detective puzzles and classification/categorization activities). Results indicate increases in the number of students using the scientific meanings of the concepts after the teaching unit. Four implications for science instruction are discussed, including the suggestion that focusing on characteristics of living things, plants, and animals be left until advanced secondary levels. (Included in appendices are highlights of major findings from exploratory/in-depth phases, details of the action-research phase, sample pages from the teaching activities booklet, and graphical representation of pre-/post-survey results.) (JN)

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LEARNING IN SCIENCE PROJECT

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TOWARD SOLUTIONS:

The work of the Biology Action–Research Group

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WORKING PAPER No. 29

MEMBERS OF THE BIOLOGY ACTION-RESEARCH GROUP

Biology Group Co-Ordinator - Beverley Bell

Miles Barker
Jane Barnett
Lenora Barrett
Marion Beecroft
Robyn Boe
Roger Cox
Erna Cullen
John Faire
Roger Osborne
Ray Scott
Neal Utting

OTHER TEACHERS WHO ASSISTED WITH THE RESEARCH

Judy Donaldson
Margaret Hamlyn
Judith Harris
Eileen Hood
Dave Munro
Monica O'Brian
Larry Simmonds
Linda Whitlock
Sue Winters
Dave Wright

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Related LISP Papers

No. 15 Living
No. 17 Energy
No. 22 Animal
No. 24 Plant
No. 30 Animal, plant, living: notes for teachers.
No. 31 Teaching about animal, plant, living.

TOWARDS SOLUTIONS: The Work of the Biology Action-Research Group

Robyn Boe, Roger Cox, Beverley Bell

November, 1981

NOTE: THIS PAPER NEEDS TO BE READ IN CONJUNCTION WITH WORKING PAPERS 30 AND 31.

1. THE PROBLEM

Many of the students in science classrooms, despite up to four years of formal science tuition, have not developed a scientifically acceptable concept of 'living', 'animal', or 'plant'. These students have a wider meaning and use of the word 'living', and narrower meanings and uses of the words 'animal' and 'plant', than would a scientist. (A fuller description of children's concepts of 'living', 'animal', and 'plant' is given in Appendix A). One possible explanation of this discrepancy in meanings despite teaching, may be that teachers have assumed that students have and use the scientific meanings of 'living', 'animal', and 'plant'. Consequently, they have not focussed their teaching on them.

2. THE ACTION-RESEARCH PHASE

With this problem having been identified, LISP action-research was launched to explore with teachers some possible teaching strategies aimed at modifying the pupils' concepts of 'living', 'plant' and 'animal' towards scientifically acceptable ones.

With this aim, the Action-Research Biology Group was established in February, 1981.

2.1 The Group

The members of this group included two primary teachers; two science teachers from Form 1-7 schools; four secondary science teachers - two from large, city co-ed colleges, one from a medium size rural college, one from a small, single sex city school; two science advisers; and two LISP team members. Hence, teachers from all levels of primary, intermediate and secondary education were represented.

2.2 The Research Programme

Prior to the first meeting (13 March, 1981) group members received copies of the LISP Working Papers on Living, Plants, and Animals and Energy to acquaint themselves with the in-depth phase work that had been done in this area. This background information stimulated discussion about the problems in the first meeting of the group.

In the weeks following this meeting each of the members explored the problems in their own schools and devised possible methods of resolving them.

The thoughts and experiences of each member were shared in meeting two (24 April, 1981). It was widely appreciated that students do have concepts based on their own experiences (but invariably these were not scientifically acceptable).

Therefore, it was felt that it was not so much a case of teaching the scientifically acceptable concept, but rather setting up a learning environment which forces the student to challenge his/her own concept, and eventually, finding it to be inadequate, to see the need to modify it.

Two components considered important in such a learning environment were:

(a) physical acts of categorisation of instances and non-instances by the students;

(b) group discussion centred around the reasons for the student's categorisation.

The collective teaching ideas discussed at the second meeting were written up into a booklet, titled "A Trial Booklet of Suggested Teaching Activities", (see Working Paper No.31 for a full description). The activities in the package included:

- categorising things by sorting examples
- detective puzzles
- true-false quiz
- classification into sets and subsets (words only)
- group discussions.

In addition, in the primary area emphasis was given to an integrated programme using activities in music, drama, mathematics and art. The emphasis of the activities was to promote the development of the scientific concept.

To gauge the effectiveness of these teaching activities, a survey was conducted of pupil concepts before and after the learning experiences. Fourteen teachers from eight schools trialed the activities at most levels of primary and secondary education. The teaching experiences and science background of these teachers varied. (Details of the research programme and the package of activities and surveys are given in Appendix B).

At the third meeting, on 24 July, 1981, the results from the pre- and post-teaching surveys were presented. The teaching activities and other aspects of the action-research were discussed in depth.

2.3 Results and Discussion

2.3.1 Pre-teaching Surveys

The results of the pre-teaching surveys used by group members with classes in their schools are illustrated in Figures 1, 2, 3, 4, and show which scientific examples and non-examples of 'living', 'animal' and 'plant', students of varying ages, (new entrants to Form 6) also considered to be 'living', an 'animal', and a 'plant'.

These results support the findings of the in-depth phase that many students over-extended the concept of 'living' (Fig. 1) and have a restricted concept of 'animal' (Fig. 2 & 3), and of 'plant' (Fig. 4).

Students of all ages, correctly categorised the bird, person, cat and butterfly as living from a scientific viewpoint (see Figure 1). A U-shaped trend was apparent for the results of students' categorisation of the fire, sun, cloud, car and grass. The younger students (aged 5, 6) categorised the instances in a way similar to that of a scientist. For example, approximately 85% of the young students indicated that the sun

and the cloud were not living. However, more than 50% of Standard 3 and 4 students (aged 9, 10) thought the sun and fire were living. The concepts of the senior students (Form 5, 6; aged 15, 16) matched more closely with concepts of scientists with respect to examples and non-examples.

The results of the categorisation of the river are confusing as many students considered the river as living because of the living things which it could contain and support, e.g. fish, water weeds.

A possible explanation for the initial negative shift with age for the categorisation of the sun, fire, cloud, and car may be the emphasis in English language lessons on myths, legends and imagery when the metaphoric meaning of the word 'living' is focussed on rather than the scientific one.

Most students of all ages considered the large, four-legged, terrestrial mammal, the horse, to be an animal (see Figures 2, 3). The scientific non-examples of the concept 'animal', the fire and the pinetree were correctly categorised by most students.

As the students' age increases, they are more likely to categorise a person as an animal. This may be related to the developmental stages in which children become less egocentric and anthropocentric as they become older.

A U-shaped trend was apparent in the students' categorising of all the animals (from a scientific viewpoint) which were not large, terrestrial and four-legged. The concept of 'animal' which many of the 5 and 6 year old students hold was closer to the scientifically acceptable view than that of students who had had three or four years of schooling. From Form 1-2 to Form 6 more and more students categorised the instances of worm, spider, dolphin, moth, seagull, and fish as animals.

It appears that teaching may shift students' concepts away from the scientific one, especially at the primary level. This may result from the emphasis in primary school science on the study of animal groups, e.g. birds, in isolation, and without reference to the biological hierarchical classifications. These results give support to the findings of the in-depth phase that insects, birds, fish, etc., were not seen as subsets of animals, but rather as comparable sets to the set of animals. These results also reflect the common usage of the word 'animal' as synonymous to 'mammal'. The slow shift towards the scientific concept after Form 1 - 2 may be in part due to the overview and wider perspective of the ecological emphasis of the biology units, presently in the Form 1-4 syllabus.

Students' concepts of 'plant' matched the scientific concept more closely than the other two. A U-shaped trend in the results was present for some instances but it is not a marked trend (see Figure 4). In general terms, some students in a science class may not be able to classify the instances as a plant, or not, as would a scientist. The atypical result was that of the categorisation of the carrot, especially for students aged 5, 6 and 16. The fact that the carrot may have been categorised as a vegetable, its colour, and that it grows as a fleshy root underground may have influenced the students' thinking.

In summary, in most science classes, many students aged 5 to 16 years, do not have or use a scientifically acceptable concept of 'living', 'animal' and/or 'plant' with respect to examples of the concept. Also young students (aged 5) and older students (aged 16) appear to have a concept of 'living', 'animal', and 'plant' that more closely matches the scientific one than students at the upper primary, intermediate, and junior secondary school levels.

2.3.2 The Results of the Teaching Episodes

The effectiveness of the teaching unit was assessed by comparing the results of the pre- and post-teaching surveys. These survey results indicate the changes in the number of students answering the survey as would a scientist.

Two representative results from a total of eight results on teaching focussed on 'living' are illustrated in Figures 5a, b; three representative of a total of ten results on 'animal' are illustrated in Figures 6a, b, c; and three representative of a total of six results on 'plant' are illustrated in Figures 7a, b, c.

Living

At both the standard 3/4 level (see Fig. 5a) and Form 3 level (see Fig. 5b) more students categorised the instances in the post-teaching survey as would a scientist. This increase was more noticeable at the Standard 3/4 level. This may reflect the teaching style of the teacher or the age factor. Gains were not so marked with the Form 3 sample for the fire, cloud, sun and river. Even after teaching focussed on the concept of 'living', some of these older students still over-extended the scientific concept and categorised the fire, cloud, sun or river as living, thus displaying animistic, or metaphoric, thinking. As discussed earlier, the river gave rise to confusion as it was seen by many students to be living because of the living things it contained.

In discussion with the students after the post-survey was completed, it became apparent that they had difficulty in considering more than two characteristics or variables simultaneously. This means that they selected only the salient features from the list of seven characteristics of living things coded by the mnemonic "M.R.S.G.R.E.N." (Movement, respiration, sensitivity, growth, reproduction, excretion, nutrition), and cells. For example, the cloud was seen to be living because it moved or grew in size. Other characteristics such as respiration or possession of cells were not considered.

The non-instance of fire was seen to have all the "M.R.S.G.R.E.N." criteria, i.e. it moves, it needs oxygen, it responds to air movements, it can increase in size, sparks can start new fires, it produces wastes, and needs fuels. Cellular structure is the only criterion common to living things which a fire does not possess, but this was often not considered.

In our view there would be less confusion, if, when teaching the concept of 'living', teachers concentrated on clarifying the scientists' meanings for animals and plants and then used the idea of "if it is a plant or an animal, then it is living". This reduces the number of characteristics which a student needs to handle simultaneously whenever a categorisation is being made.

Animal

The results on the teaching on 'animal' are illustrated in Figures 6a, b, c and illustrate an increase in the students answering the survey as would a scientist. In other words, more students, at three different age levels, were able to demonstrate after the teaching that they had a scientific concept of 'animal'. The survey does not, however, indicate if the students appreciated the two meanings of the word animal (the everyday restricted one and the scientific one). However, in terms of science education, the teaching had been successful in promoting the scientific meaning.

Plant

Similar increases in the number of students using the scientific meaning of 'plant' after the teaching unit, are illustrated in Figures 7a, b, c.

2.4 Implications of the Results for Science Education

1. Teachers need to be aware of the possible communication problems if they and their students attach different meanings to the words 'living', 'animal', and 'plant'. They cannot assume that their students have and use scientific meanings for these words. The instructions "collect two different animals and put them in a jar", may be interpreted differently by the teacher and the student.

2. Teaching activities focussing specifically on these concepts do help students develop scientifically acceptable concepts of 'living', 'animal' and 'plant'. The length of time spent may vary from 2-3 weeks in the primary school to 1-2 periods in the senior secondary school. While the focus of the teaching may change (see Appendix B) there is a need to revisit these 3 concepts at different age levels (primary to secondary).

3. Other research [Barker, M. (1981) unpublished Dip.Ed. thesis, Massey University] has shown that students who have and use a scientific concept of 'animal', develop a scientific concept of consumer more readily than students who have a restricted concept of 'animal'.

Two third form classes were pre- and post-tested about their concepts of animal and consumer (Figures 8 and 9). The control class received 'normal' lessons on consumers, producers, decomposers, etc., while the other class (experimental) were taught what an animal is in the scientific meaning of the word. Only at the end of the lesson was the concept of animal related to the concept of consumer. The results in Figure 9 illustrate the effectiveness of being aware of children's ideas and teaching accordingly.

The results also suggest that the difficulties students experience with the abstract ecological concepts, now emphasised in the Form 1-4 syllabus may be in part due to students not having scientifically acceptable concepts of basic ideas, such as 'living', 'animal', and 'plant'. It may be more efficient to focus on these basic concepts in science lessons prior to Form 3/4 and leave teaching on ecological concepts until the later secondary level.

4. Teaching focussing on the characteristics (criteria) of living things animals, and plants may be best left until the junior or even senior secondary level. The scientific criteria are often abstract ideas themselves, e.g. respiration as a characteristic of living things; autotrophic feeding and cell structure for plants. The traditional characteristics of living things (M.R.S. G.R.E.N.) may promote animism in students, especially with such instances as the fire and sun. Therefore, teaching, prior to Form 3, would emphasise the categorisation or examples and non-examples of each concept only.

3. FINAL OUTCOMES OF THE ACTION-RESEARCH GROUP WORK

As a result of the above work two booklets for direct use by teachers have been prepared. The first booklet is a summary of the in-depth phase work and it is written to help teachers appreciate both children's views and the scientists' views on animals, plants and living.

The second booklet arises directly out of the action-research phase work and is a booklet of suggested teaching activities for use by teachers at all levels. It is a modified version of the initial trial booklet of suggested teaching activities.

Currently these booklets are available as Working Papers of the Learning in Science Project.

(a) Animal, Plant, Living.
Notes for Teachers
Working Paper No. 30, Learning in Science Project.

(b) Teaching about Animal, Plant and Living.
Suggested Teaching Activities
Working Paper No. 31, Learning in Science Project.

APPENDIX A: Relevant Work of Earlier Phases of LISP

1. The Learning in Science Project

The Learning in Science Project (LISP) was established in February 1979 to make a detailed study of the teaching and learning of science at the Forms 1-4 level; to identify some of the key difficulties, and to investigate possible ways of helping to overcome such difficulties. It was hoped that the project, through objective research, could provide information on which further science syllabus modifications could be based.

To achieve the project's aim a three-step programme was adopted:

"(a) an exploratory phase to observe the teaching and learning of science in classrooms and to identify difficulties as perceived by teachers, pupils, and experienced classroom observers;

(b) an in-depth phase to focus on the teaching and learning of selected aspects of the science course, for example, topics or themes; and

(c) an action-research phase, based on the findings of the first two phases, to explore with teachers possible ways of overcoming the identified difficulties and problems in teaching and learning science."

This working paper relates to the research on the teaching and learning of biology in Forms 1-4.

2. Results of the Exploratory Phase indicated that:

(a) Most of the pupils and teachers interviewed enjoyed biology.

(b) Many teachers were more confident about teaching the biology units than the physics and chemistry ones. However, classroom observations indicated that difficulties experienced by teachers, are not always realised by them. Teachers' confidence may be due to their familiarity with the common, not biological, meaning and use of many words.

(c) Some teachers and other people concerned with science education expressed concern at the placement of ecological concepts in Forms 1-4 biology curriculum. In particular, the ecological concepts were felt to be too abstract for children of that age, and that the children lacked the prerequisite knowledge of individual animals and plants to undertake a study of ecology.

The results of an in-depth phase investigation (see Working Paper No.17) indicated that children's meanings for the word 'energy' are limited and illustrate an inability to cope with the abstract concept of energy even at the Form 5 level. The appropriateness of including ecological studies, in their present form in the Forms 1-4 science syllabus was again questioned. But what is appropriate? To clarify this issue, we need to be aware of what concepts the pupils already hold, and work from this base.

Three concepts basic to a study of ecology, and in fact biology, are 'living', 'animal' and 'plant'. Their common usage in biological texts and lessons implies that pupils do have meanings or concepts to attach to these labels. But what concepts do pupils have and how similar are they to the scientifically acceptable ones? (See Working Paper No.30 for a description of the scientific concepts). The in-depth phase of the programme focussed on these questions.

3. Results of the In-Depth Phase

There are two aspects of the meanings students have for the word 'living', 'animal', or 'plant'. Firstly, what do students consider to be examples of living things, animals and plants? Secondly, what reasons or characteristics do students use to categorise something as living or not-living, animal or plant?

The results of the in-depth phase may be summarised as:

3.1 Students' meanings of the word 'living' (See Working Paper No.15 for a full account)

Many students have a wider meaning of the word 'living' than that used by a scientist. They have more examples of living things than would a scientist. Some students consider a fire, cloud, river, car, bike and the sun to be living whereas a scientist would not.

Some of the reasons used by students to classify something as living or non-living are acceptable to scientists, e.g. movement, feeding, growth, senses, reproduction, cells. However, these reasons are also used to classify as living, things that a scientist would consider non-living, e.g. cloud, river, fire.

Some students use reasons that would not be used by a scientist to categorise something as living, e.g. gives off energy, makes a noise, usefulness.

However, we as adults, also use this wider meaning of the word 'living' when we use this word in a metaphoric sense. For example, we talk of the 'living bible', or of the 'living flame' in advertisements for natural gas. We use the word as if the bible or flame was living. We may not consider the book or flame to be living from a scientific viewpoint but we may consider it living in a metaphoric sense, as if it was living.

If we are to understand the message in such phrases we must interpret the word 'living' in the metaphoric not scientific sense. Science teachers, may need to clarify to the students, which is the appropriate meaning to use in different situations.

3.2 Students' meanings of the word 'animal' (See Working Paper No.22 for a full account)

Many students see animals as only the large land mammals, such as those on a farm, in a zoo, or jungle, or in the home as pets. Their range of examples of animals is narrower or more restricted than that of a scientist. Many students, including Form 5 and 6 students did not consider a worm, a spider, or a fish, for example, to be animals whereas a scientist would.

The reasons used by many students to categorise something as an animal differ from those used by a scientist. Examples of such reasons are number of legs, size, habitat, fur.

Other reasons used by students are similar to those used by scientists to decide if something is an animal or not. Examples of these reasons are movement, a nervous system, and mode of feeding.

We as adults often use this restricted meaning when we use the word 'animal' in an everyday sense. A scientist considers people as animals as they are consumers, move, have a nervous system, sense organs and have cells without cell walls. However, many food shops display the sign

"No Animals Allowed".

If we interpret the sign from a scientific viewpoint we cannot go in. To understand the intended message, we need to interpret the word 'animal' in the everyday or restricted sense, that is, meaning only cats, dogs, horses, etc. We as science teachers, need to clarify to students that there are two meanings for the word 'animal'. One (the narrower meaning) is appropriate to use in an everyday situation, and one (the wider meaning) is appropriate to use in the scientific situation (say in the science lesson).

3.3 Students' meanings of the word 'plant' (See Working Paper No.24 for a fuller account)

Many students have a narrower meaning of the word 'plant' than that of a scientist. Many did not consider the vegetables, the weeds and hard, large trees to be plants, as would a scientist.

Few students use the scientifically acceptable abstract reasons of producer feeding and cell structure to categorise something as a plant. The reasons used by students, while not characteristic of all plants, do pertain more to plants than to animals. Examples of such reasons are possession of leaves, flowers, stem, roots and immobility.

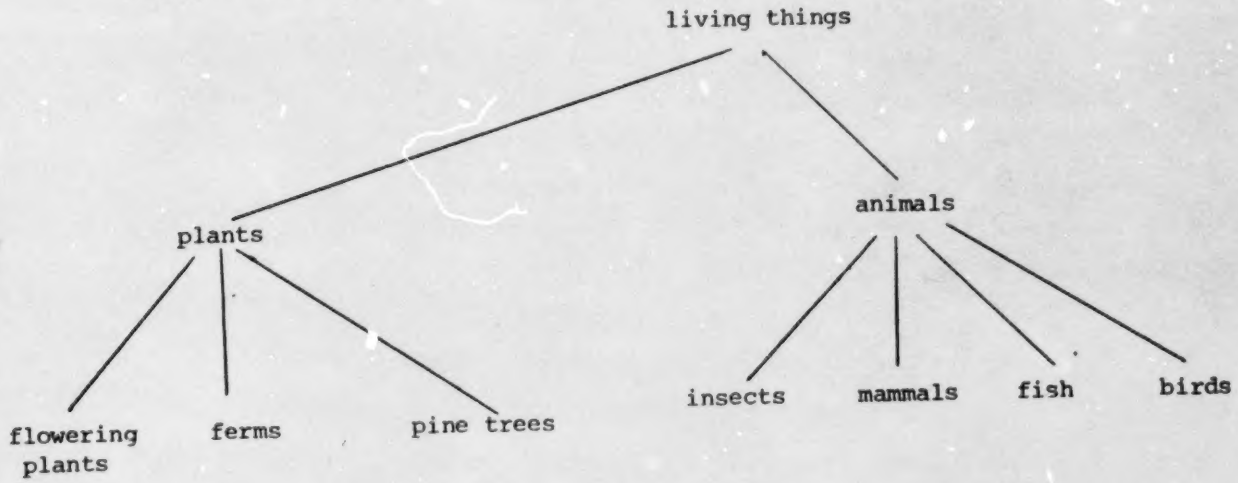
Some students do use reasons that are unacceptable to a scientist to categorise something as a plant or not, for example, size, hardness, cultivation.

As with the word 'animal' there appears to be an everyday meaning of the word 'plant' that has a narrower meaning than the scientific one. Science teachers need to clarify to students that there are two meanings for the word, and when it is appropriate to use each of these two meanings.

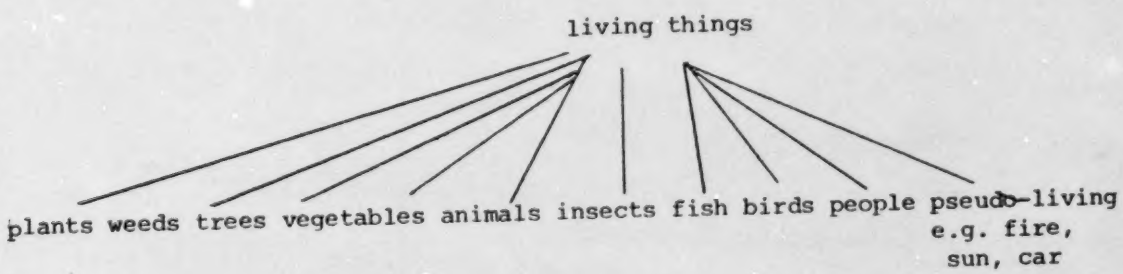
3.4 Summary

The meanings children give to the words 'living', 'animal' and 'plant' indicate that their hierarchial categorisation of living things may not be the same as that of a scientist.

For example, a scientist's categorisation of living things may be simply represented as:



For many students, the categorisation may be represented as



The biological subsets of trees, vegetables, weeds and of people, insects, fish and birds are seen as comparable sets to the sets of plant and animal, not as subsets.

In summary the findings of the work of the in-depth phase of LISP related to Biology found that children do have meanings for the words 'living', 'animal' and 'plant'. But these meanings are often different to the scientific meanings. Children often have a wider meaning of the word 'living' and narrower meanings of the words 'animal' and 'plant' compared to that of a scientist. These meanings used by children correspond to the metaphoric use of the word 'living' and to everyday use of the words 'animal' and 'plant'.

APPENDIX B: Details of the Action-Research Programme

Action-Research Guidelines

1. Read the Trial Booklet for Teachers - Animal, Plant and Living. This booklet describes why we need to focus teaching on these three basic words or concepts.

2. Decide whether to focus the teaching and learning on the living or animal/plant, or all three.

3. Administer to the class survey A of animal (Survey 1A), plant (2A) or living (3A) depending on which word(s) you decide to focus the teaching and learning on.

   Refer to the sheet labelled "Instructions for Administering the Surveys".

4. Record the results on a chart headed "Survey Results".

5. Consult the "Trial Booklet of Suggested Teaching Activities" and plan a teaching episode, taking into account the results of the survey.

6. Conduct the lessons on living, and/or animal and plant.

7. In a week following the last lesson, administer the B survey for the word(s) concerned - animal (1B), plant (2B), living (3B). Give only one survey per day to avoid confusion.

8. Record the results on the chart headed "Survey Results" in the appropriate column.

9. Complete the Feedback Sheets on
   i) the Trial Booklet for Teachers on Living, Animal, Plant,
   ii) the surveys,
   iii) the Trial Booklet of Suggested Teaching Activities.

Details of the Content of the Package Sent to the Action-Research Group Members

1. A pamphlet giving general information on the Learning in Science Project.

2. Action-Research Guidelines.

3. Trial Booklet for Teachers - Animal, Plant and Living.

4. Six overhead projector transparencies. These are the six master sheets of the surveys - animal, (surveys 1A, 1B); plant (2A, 2B); and living (3A, 3B).

5. Six answer sheets - one for each of the six surveys.

6. Instructions for Administering the Surveys.

7. A sheet, Survey Results, on which to collate the results of the survey.

8. A Trial Booklet of Suggested Teaching Activities.

9. Feedback Sheets on:

   i) the Trial Booklet for Teachers on Animal, Plant and Living,

   ii) the surveys,

   iii) the Trial Booklet of Suggested Teaching Activities.

APPENDIX B

THE FOCUS OF THE TEACHING AT DIFFERENT LEVELS

A PAGE FROM THE TEACHING ACTIVITIES BOOKLET.

Level 1 (J1 - J3)

increasing children's awareness of the things we call living things, animals, and plants by getting them to observe these different kinds of things.

Level 2 - 3 (Std.2 - Std.4)

(a) developing the skill of categorising.

(b) categorising things into the groups of living, non-living, dead and animal and plant as would a scientist.

Level 4 (Form I - II) and Level 5 (Form III - IV)

(a) and (b) as for level 2 - 3.

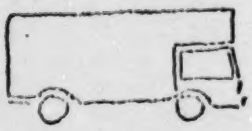
(c) contrasting the scientists meaning for these words with the metaphoric and everyday use of the words.

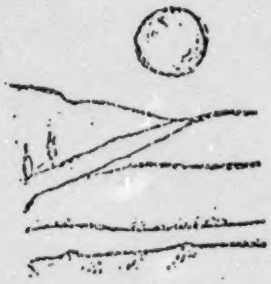
(d) the reasons scientists use for categorising things into living, non-living, animal and plant.

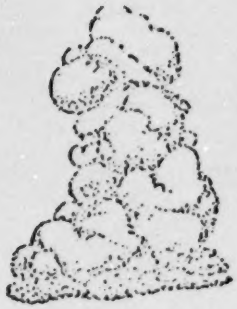
INSTRUCTIONS FOR ADMINISTERING THE SURVEYS

For each word or concept there are two surveys. The A survey for each word is to be given before the teaching and learning episode, and the B survey after.

IS IT LIVING?

1. 

2. 

3. 

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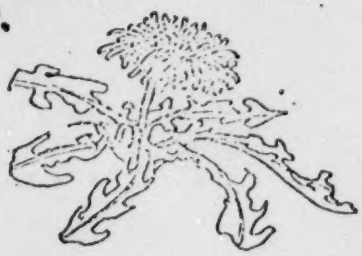
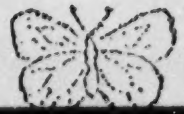
5. 

6.

7.

8.

9. 

10.

IS IT LIVING?

Put a tick (✓) in one of the squares

1.	Is a truck living?	Yes ☐	No ☐
2.	Is the sun living?	Yes ☐	No ☐
3.	Is a cloud living?	Yes ☐	No ☐
4.	Is a seagull living?	Yes ☐	No ☐
5.	Is a dandelion living?	Yes ☐	No ☐
6.	Is a person living?	Yes ☐	No ☐
7.	Is a river living?	Yes ☐	No ☐
8.	Is a dog living?	Yes ☐	No ☐
9.	Is a moth living?	Yes ☐	No ☐
10.	Is a fire living?	Yes ☐	No ☐

Surveys 1A and 1B are about the word animal,
Surveys 2A and 2B are about the word plant,
Surveys 3A and 3B are about the word living.

Give only one survey per day (either 1A, 2A, or 3A; either 1B, 2B or 3B)

1. Hand out the answer sheets, one to each students. Check that the number, e.g. 1A, matches the number on the master sheet (the picture sheet).
2. Put the master sheet on the overhead projector. Explain what they are required to do and how they indicate their answer on the answer sheet.
3. The survey normally takes about 5-10 minutes to complete.
4. Collect in the answer sheets.

NOTE:

1. For the younger children either:

   (a) Go through the survey with individual children. Point to the picture on the master sheet and ask if it is an animal (or plant or living). The teacher then places a tick in the appropriate square on the answer sheet.

OR:

   (b) Go through the survey as a whole class but the students indicate their choice of answer by a show of hands. The teacher counts the number of hands for a 'yes' answer and for a 'no' answer, and records this on one answer sheet.

2. If no overhead projector is available, the master sheets can be photostated and a copy handed to each student.

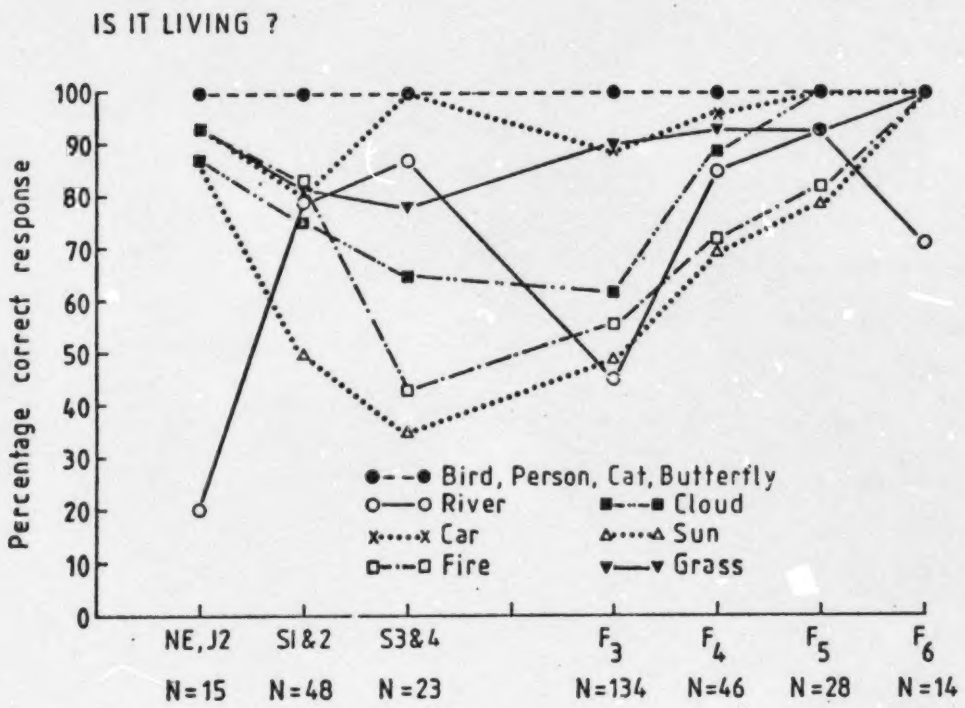


Figure 1. The Results of the Pre-teaching survey on'Living'.

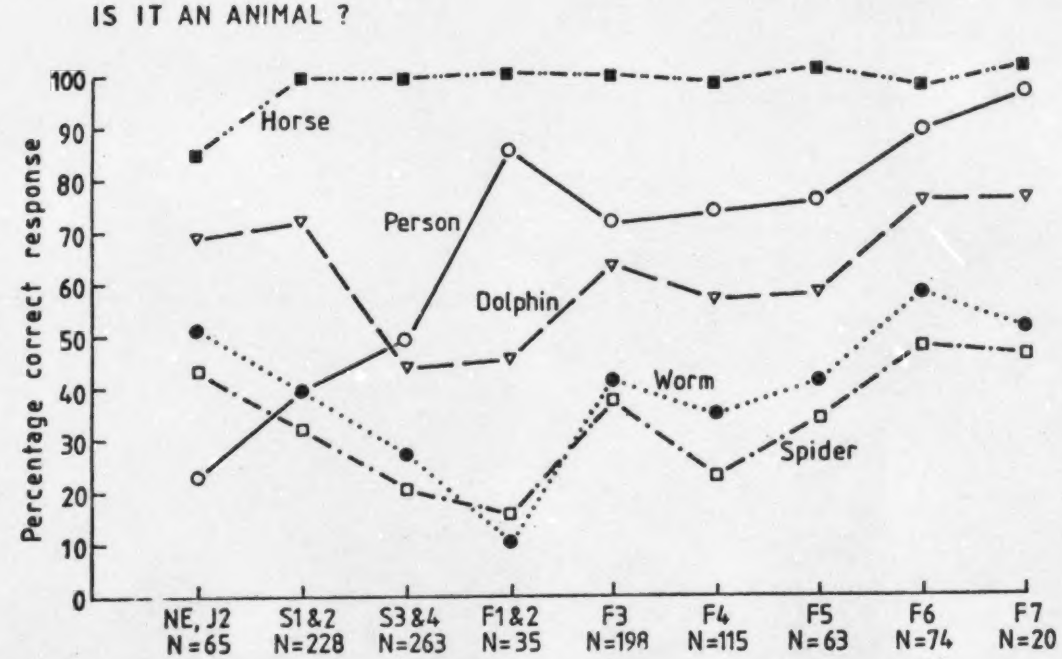


Figure 2: The Results of the Pre-teaching surveys on 'Animal' : Part 1.

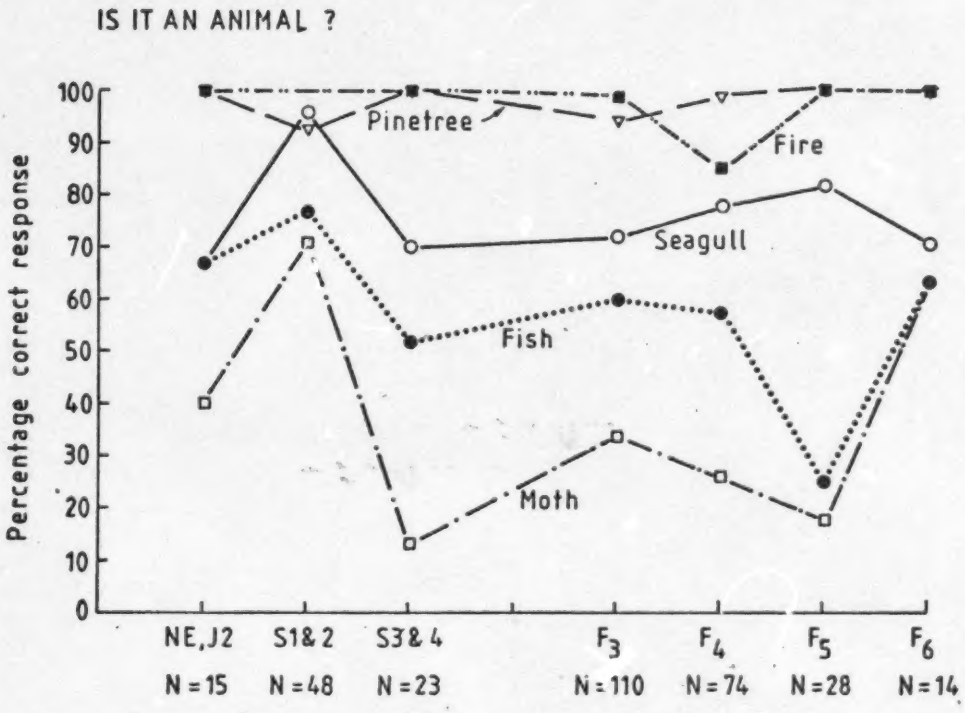


Figure 3: The Results of the Pre-teaching Survey on 'Animal' Part 2.

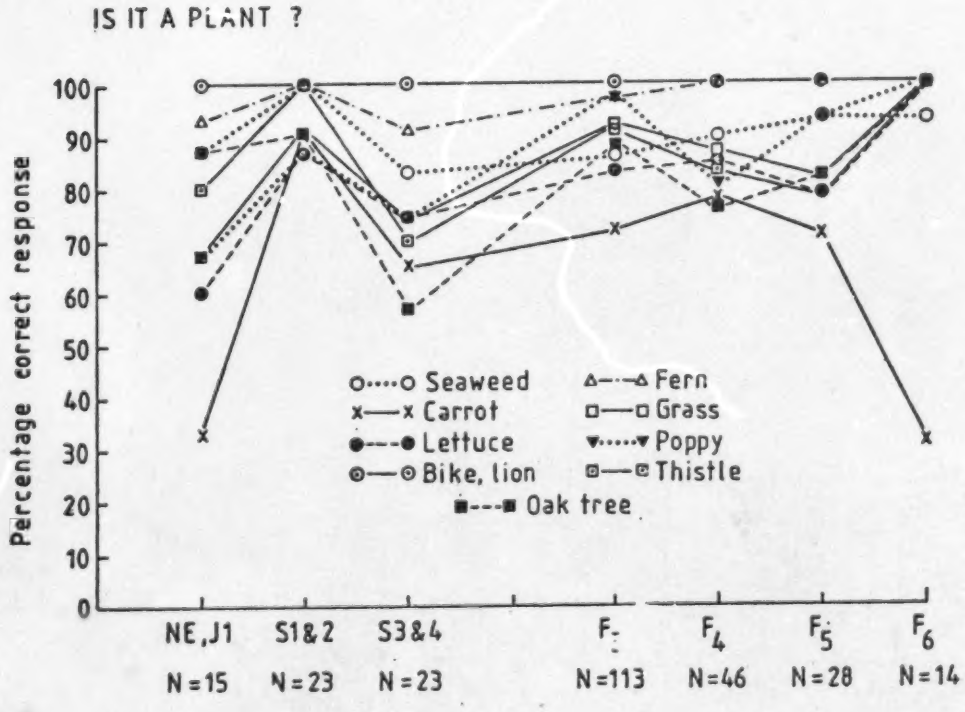


Figure 4: The Results of the Pre-teaching surveys on 'Plant'.

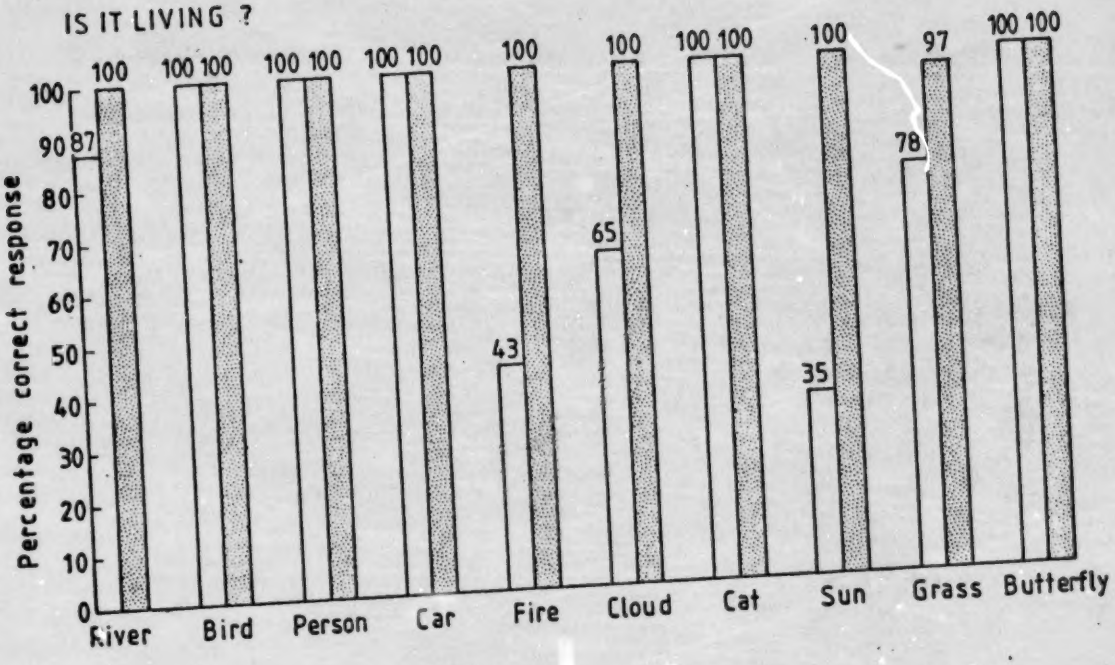


Figure 5a : The Pre- and Post-teaching Survey Results - Living (N=23, age 9/10,Std. 3/4)

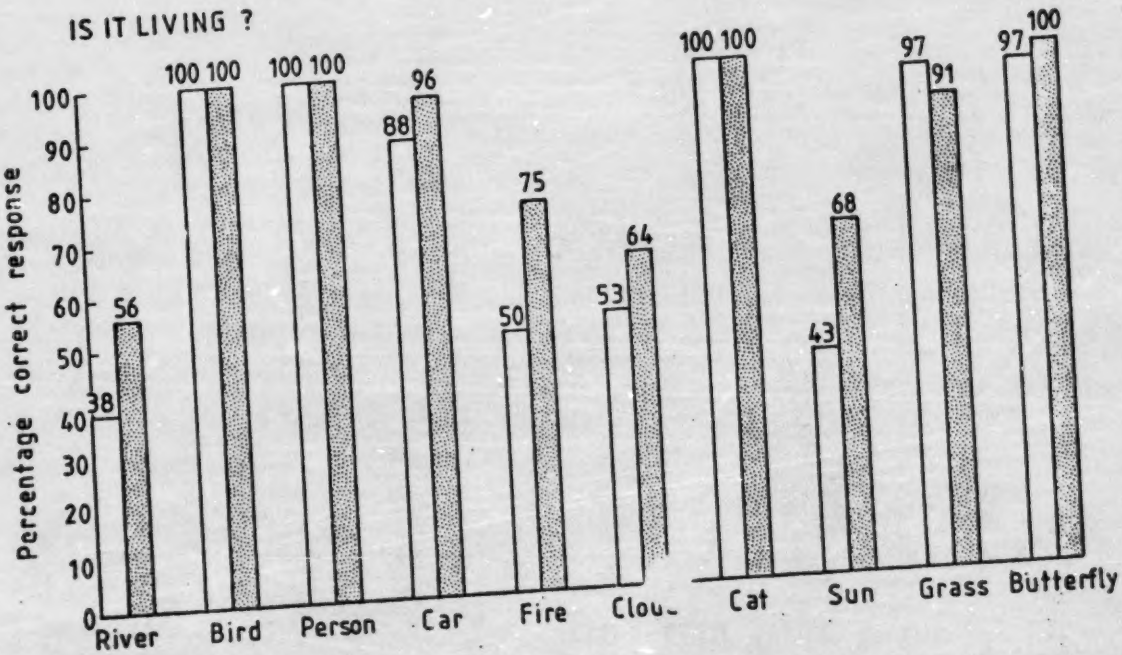


Figure 5b: The Pre- and Post-teaching Survey Results - Living (N=60, age 13, Form 3)

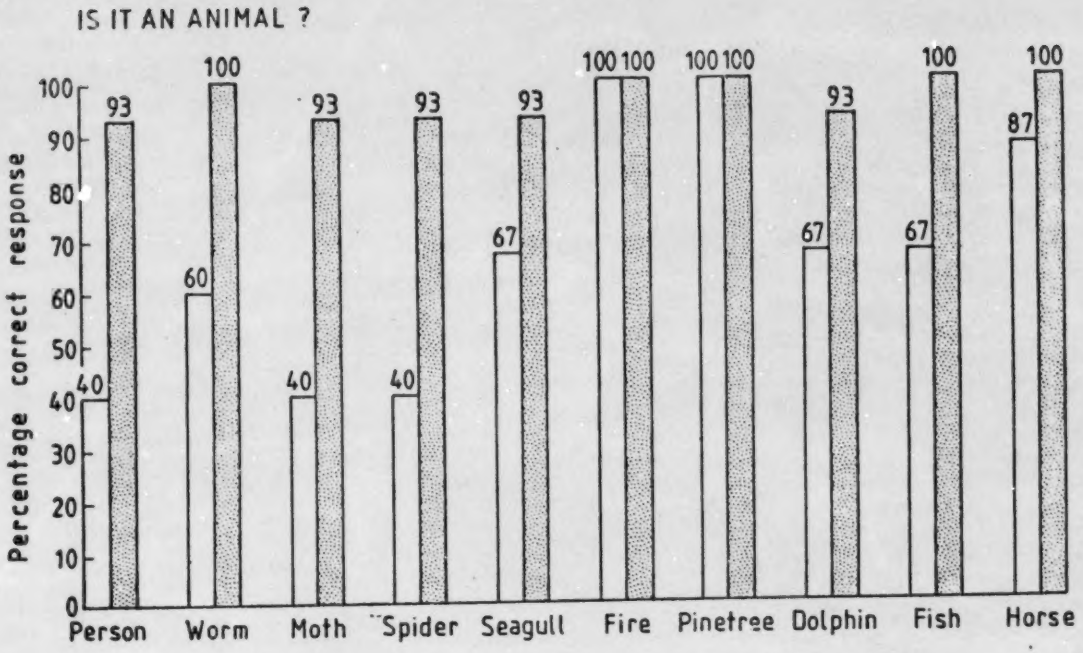


Figure 6a: The Pre- and Post-teaching Survey Results - Animal (N=15, age 5, New Entrants)

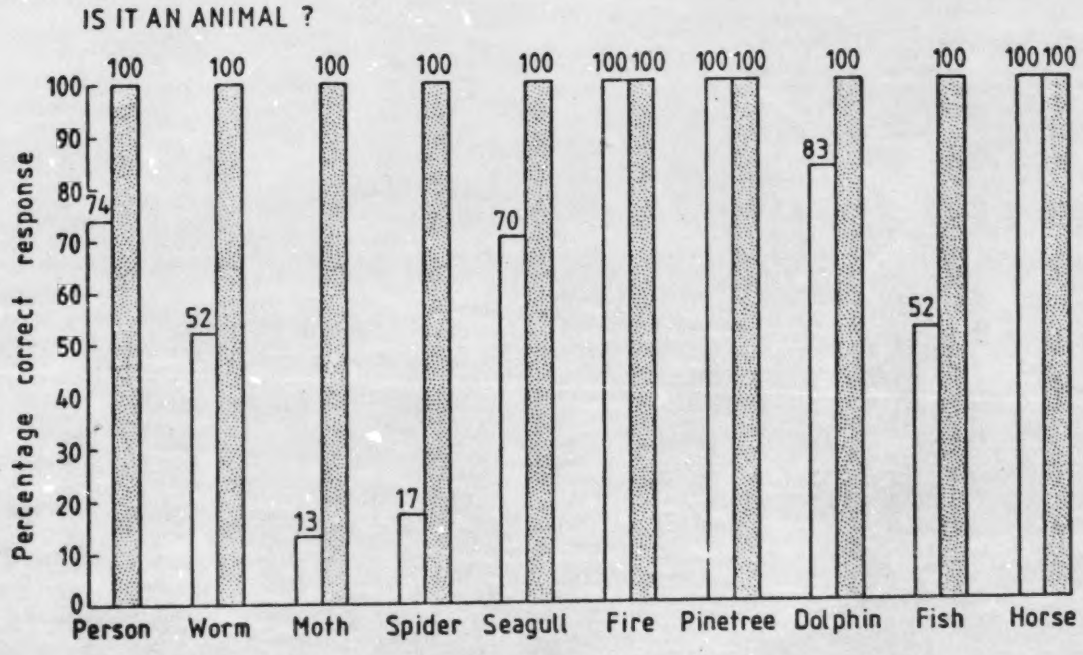


Figure 6b: The Pre- and Post-teaching Survey Results - Animal (N=23, age 9,10, Std 3/4)

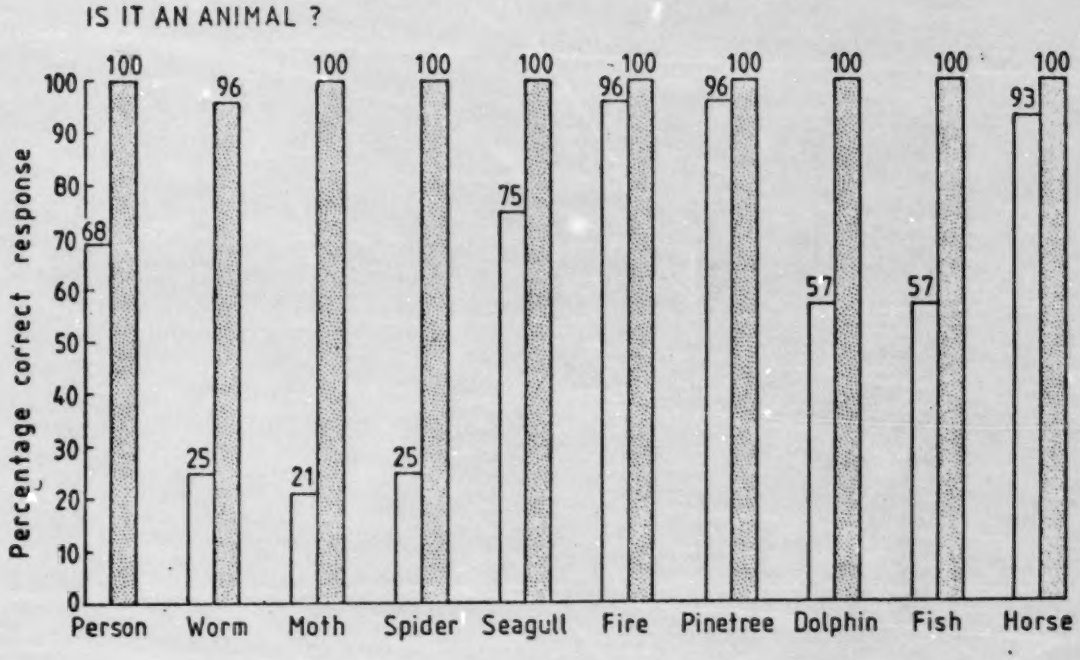


Figure 6c : The Pre- and Post-teaching Results - Animal (N=28, age 14, Form 4)

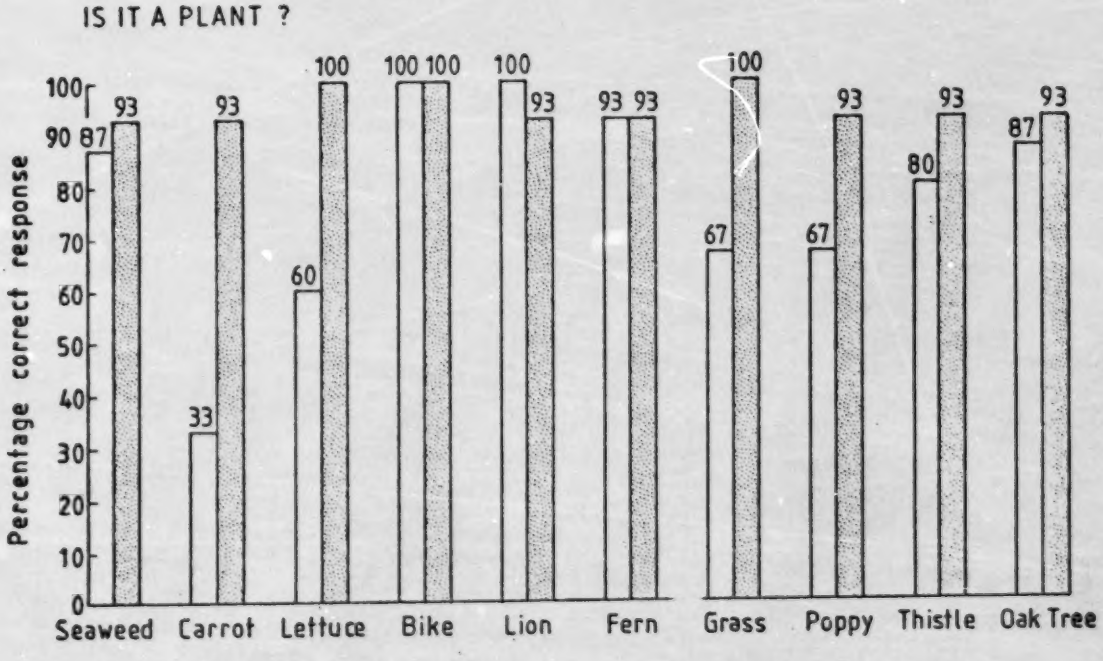


Figure 7a: The Pre- and Post-teaching Survey Results - Plants (N=15, age 5, new entrants)

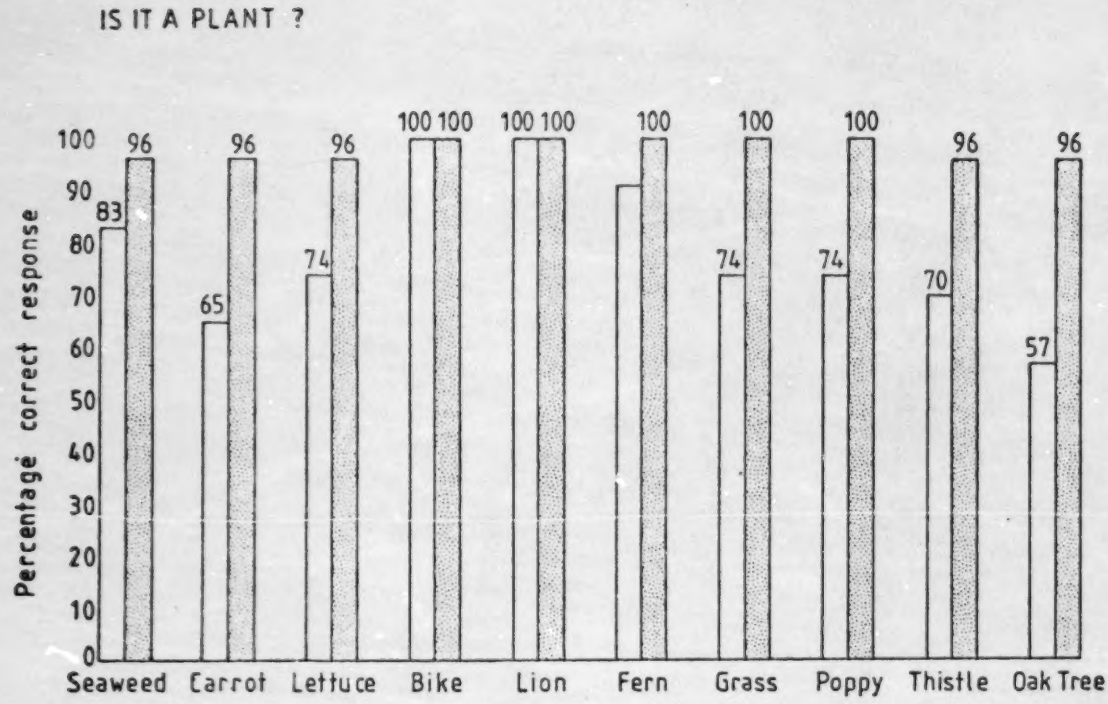


Figure 7b: The Pre- and Post-teaching Results - Plant (N=23,age 9,10, Std 3/4)

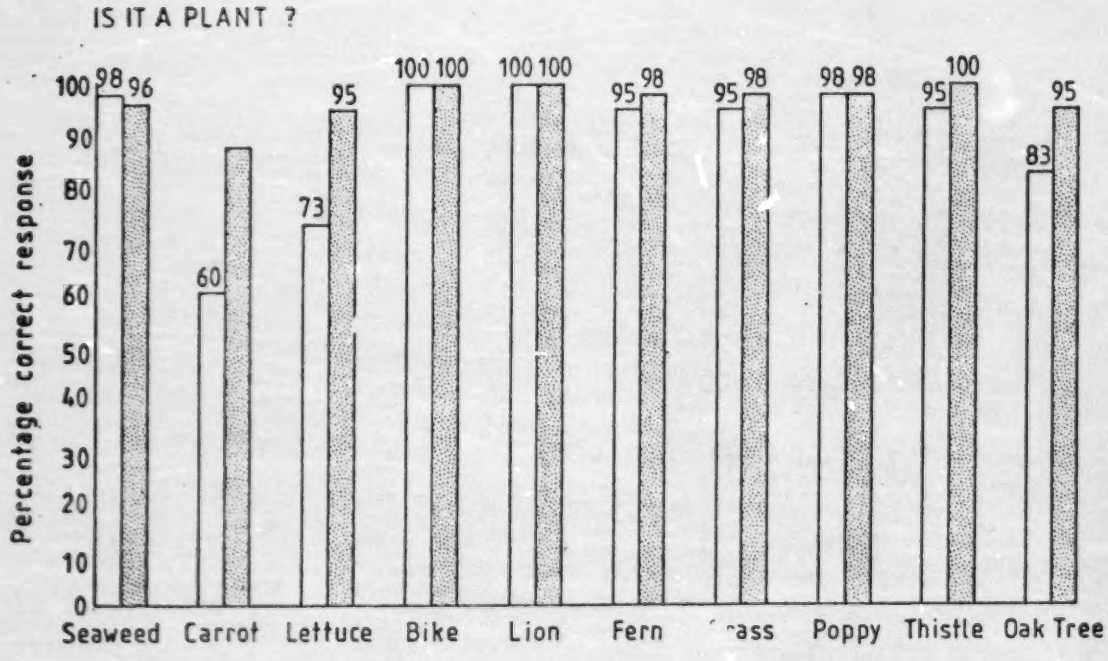


Figure 7c: The Pre- and Post-teaching Results - Plant (N=60, age 13, Form 3)

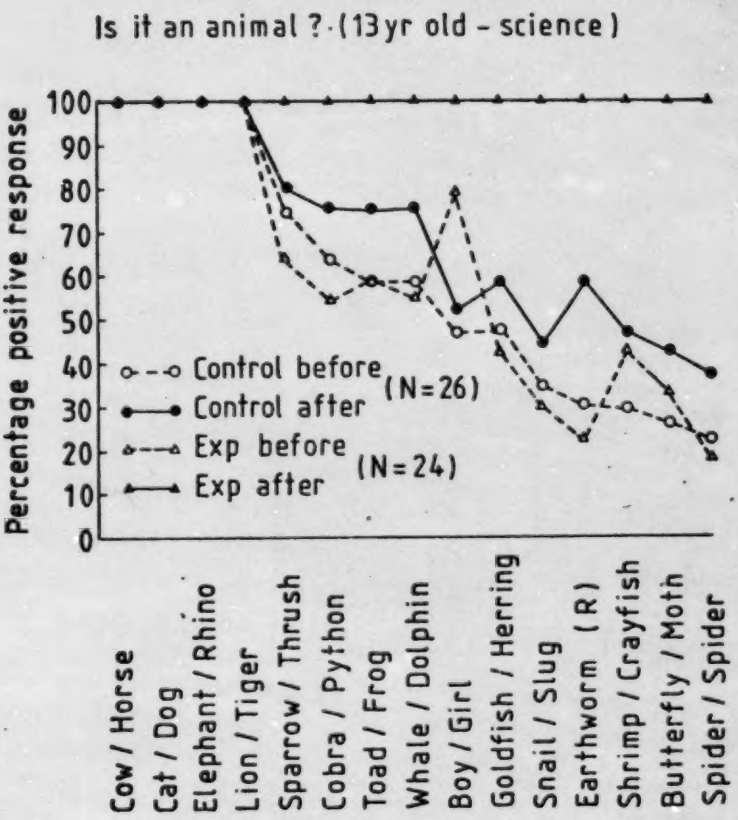


Figure 8: Pre- and Post-teaching results for a class which had teaching focussing on 'animal' (the experimental group) and a class which had no specific teaching on 'animal' (the control). (Barker, 1981)

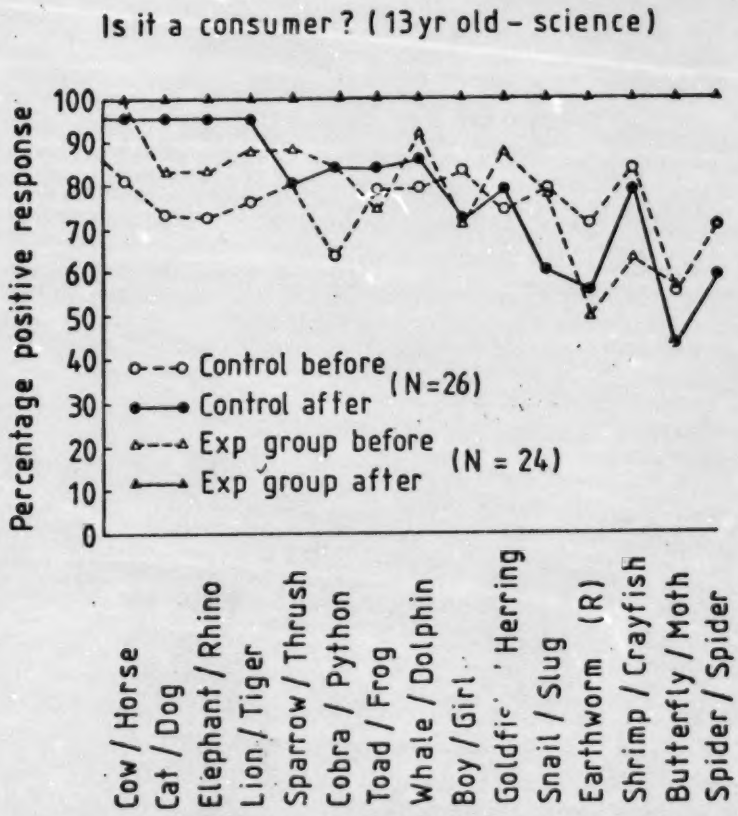


Figure 9: Pre- and Post-teaching results for a class which had teaching on the word 'animal' before that on the word 'consumer' (the experimental group).